Azimuthal correlation measurements with ALICE at the LHC *

M. Krzewicki[1,2], J. Onderwaater[1,2], and I. Selyuzhenkov[1,2] for the ALICE Collaboration

[1]ExtreMe Matter Institute EMMI and GSI Helmhotzzentrum für Schwerionenforschung, Darmstadt; [2]Frankfurt Institute for Advanced Studies (FIAS), Germany

Anisotropic flow in heavy-ion collisions is a key observable related to the early time evolution of the nucleus-nucleus interaction. We report on recent results of the ALICE Collaboration at the LHC on the directed flow of charged particles relative to the spectator plane in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV. Also recent findings from the search for effects of local parity violation in the strong interaction are presented.

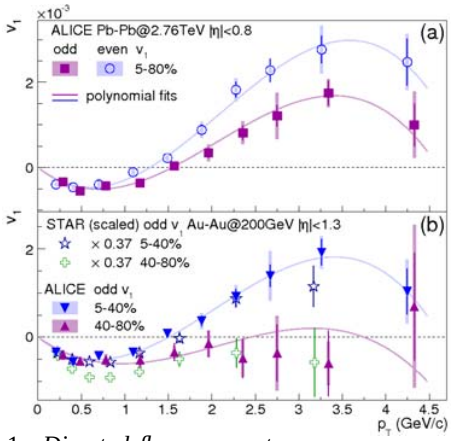

Figure 1: *Directed flow versus transverse momentum in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV. (a) v_1 for 5-80% centrality range. (b) $v_1^{\rm odd}$ in Pb-Pb collisions compared to Au-Au collisions at RHIC at $\sqrt{s_{\rm NN}} = 200$ GeV downscaled with a factor 0.37.*

Directed flow, v_1, is a probe of the spatial orientation and fluctuations of the shape of the fireball created in a heavy-ion collision. The observed negative slope [1] of the rapidity-odd v_1 component is about three times smaller than observed at the highest RHIC energy, suggesting a smaller longitudinal tilt of the initial system and disfavours the picture of strong fireball rotation predicted at the LHC energies. Measured for the first time with respect to the spectator nucleons, the rapidity-even v_1 component is found to be independent of pseudorapidity and changes sign at transverse momenta around $1.2 - 1.7$ GeV/c (figure 1). This is expected for dipole-like energy fluctuations when momentum of the low $p_{\rm T}$ particles is balanced by that of the high $p_{\rm T}$ particles. The magnitude of the rapidity-even v_1 w.r.t. the participant plane has a similar shape, but is a factor of forty larger, which indicates that fluctuating participant and spectator planes are weakly correlated. Compared to the measurements at the highest RHIC energy, in figure 1(b), $v_1^{\rm odd}$ shows a similar trend including the sign change around $p_{\rm T} \sim 1.5$ GeV/c in central collisions and negative value at all $p_{\rm T}$ for peripheral collisions.

* Supported by GSI, BMBF, HGS-HIRe, and Helmholtz Alliance HA216/EMMI

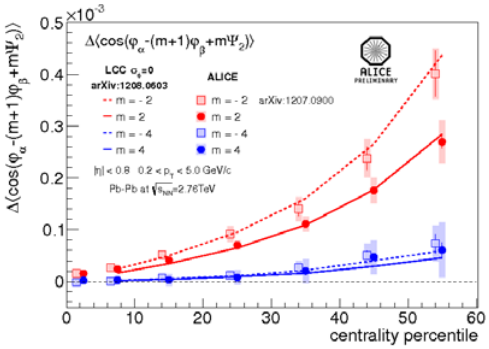

Figure 2: *Centrality dependence of the correlation $\Delta\langle\cos[\varphi_\alpha - (m+1)\varphi_\beta + m\Psi_2]\rangle$ in comparison with the Blast Wave model incorporating effects of local charge conservation. Δ denotes the difference between same and opposite charge correlations.*

The parity symmetry violation in strong interactions remains one of the open fundamental questions about QCD. It is argued that parity symmetry can be locally violated in a heavy-ion collision which will result in an experimentally observable separation of charges along the extreme magnetic field generated by the moving ions, the so called chiral magnetic effect (CME). An experimental probe of CME are the azimuthal correlations with respect to the collision reaction plane which is perpendicular to that magnetic field.

ALICE observed a clear charge dependence of the two-particle correlation with respect to the reaction plane [2]. This can be due to a number of other charge-dependent effects which preserve parity, such as local charge conservation (LCC). Higher order charge-dependent correlations help to disentangle parity conserving contributions from CME. Recent ALICE results, in figure 2 , show that models which combine LCC and the radial expansion of the medium, while failing to describe the correlation $\Delta\langle\cos n(\phi_\alpha - \phi_\beta)\rangle$ in figure 3 [3]), give a good description of the correlations shown in figure 2 up to higher orders. This suggests that a significant fraction of the observed two-particle correlation may be due to LCC. A study of charge-dependent correlations with identified particles was also recently started to further disentangle the CME and LCC contributions.

References

[1] B. Abelev *et al.* [ALICE Collaboration], Phys. Rev. Lett. **111** (2013) 232302

[2] B. Abelev *et al.* [ALICE Collaboration], Phys.Rev.Lett. **110** (2013) 012301

[3] Y. Hori [ALICE Collaboration], Nucl. Phys. A904-905 **2013** (2013) 475c

 doi:10.15120/GR-2014-1-NQM-ALICE-08